Integration of Remote Sensing in IRI's Climate and Environmental Monitoring Activities for Food Security, Human Health, and Disaster Management

Pietro Ceccato

International Research Institute
for Climate and Society
EARTH INSTITUTE | COLUMBIA UNIVERSITY

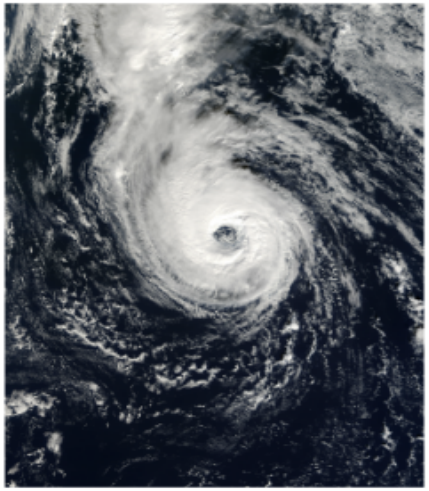
The mission of the IRI is to enhance society's capability to understand, anticipate and manage the impacts of climate in order to improve human welfare and the environment.

What do we mean by

"impacts of climate"?

droughts.

hurricanes.



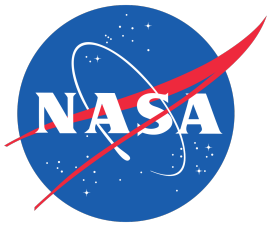
floods.

fire risk.

pest outbreaks.

epidemics.

Partners...



Swiss Re

WFP
World Food Programme

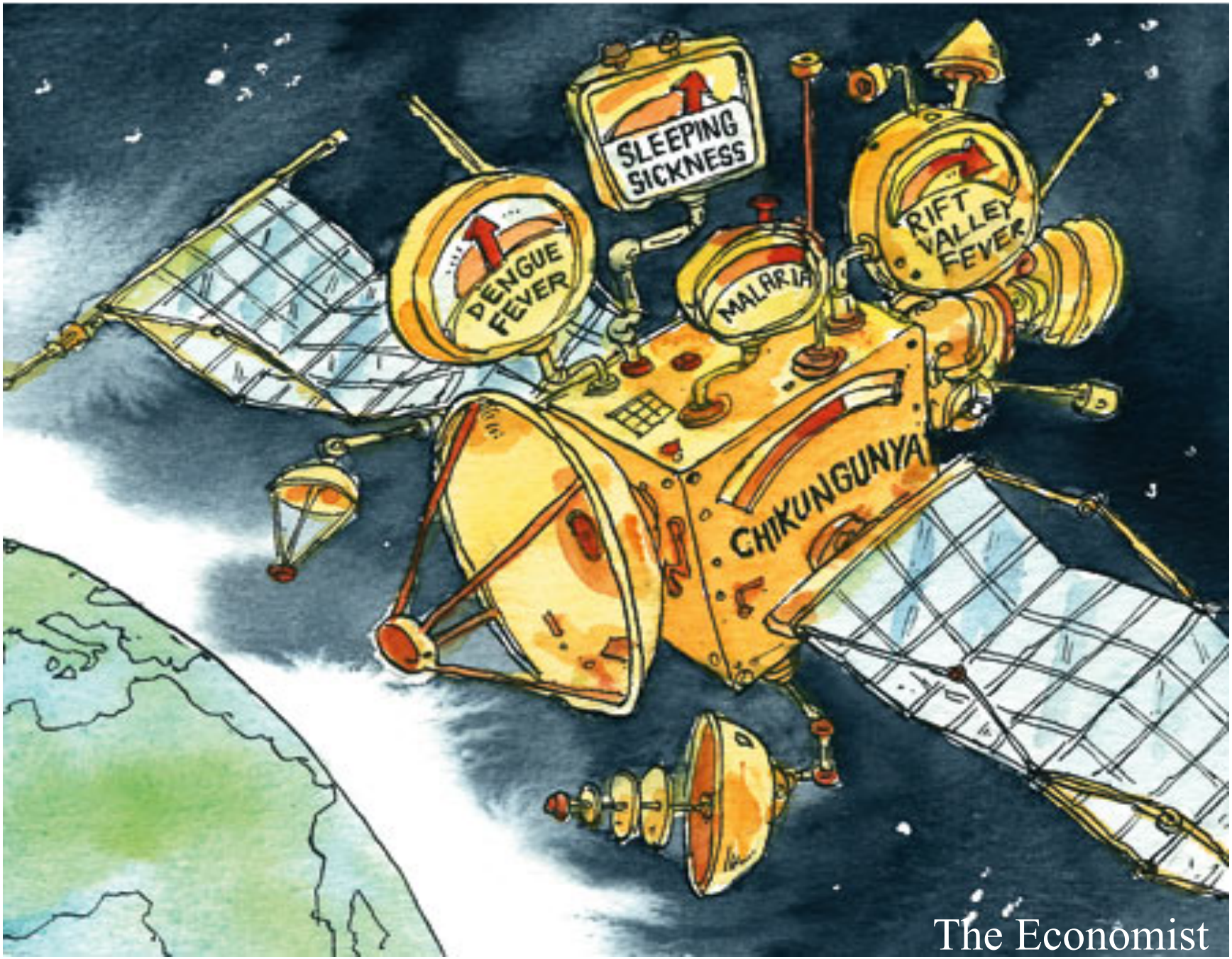
World Health Organization

IFAD
Enabling poor rural people to overcome poverty

International Federation of Red Cross and Red Crescent Societies

How to monitor climate?

And in particular diseases?

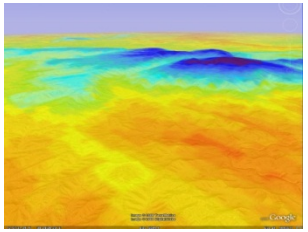

SLEEPING SICKNESS
DENGUE FEVER
MALARIA
RIFT VALLEY FEVER
CHIKUNGUNYA
The Economist

Parameters

Precipitation

Vegetation

Temperature

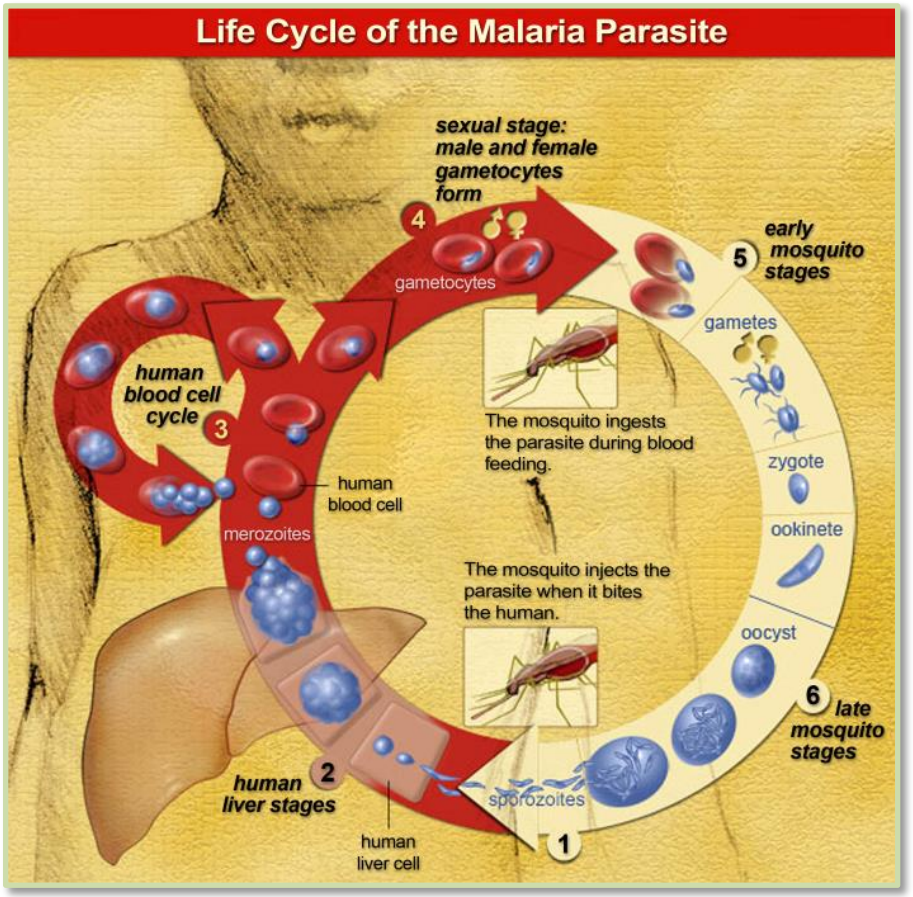


Water Bodies

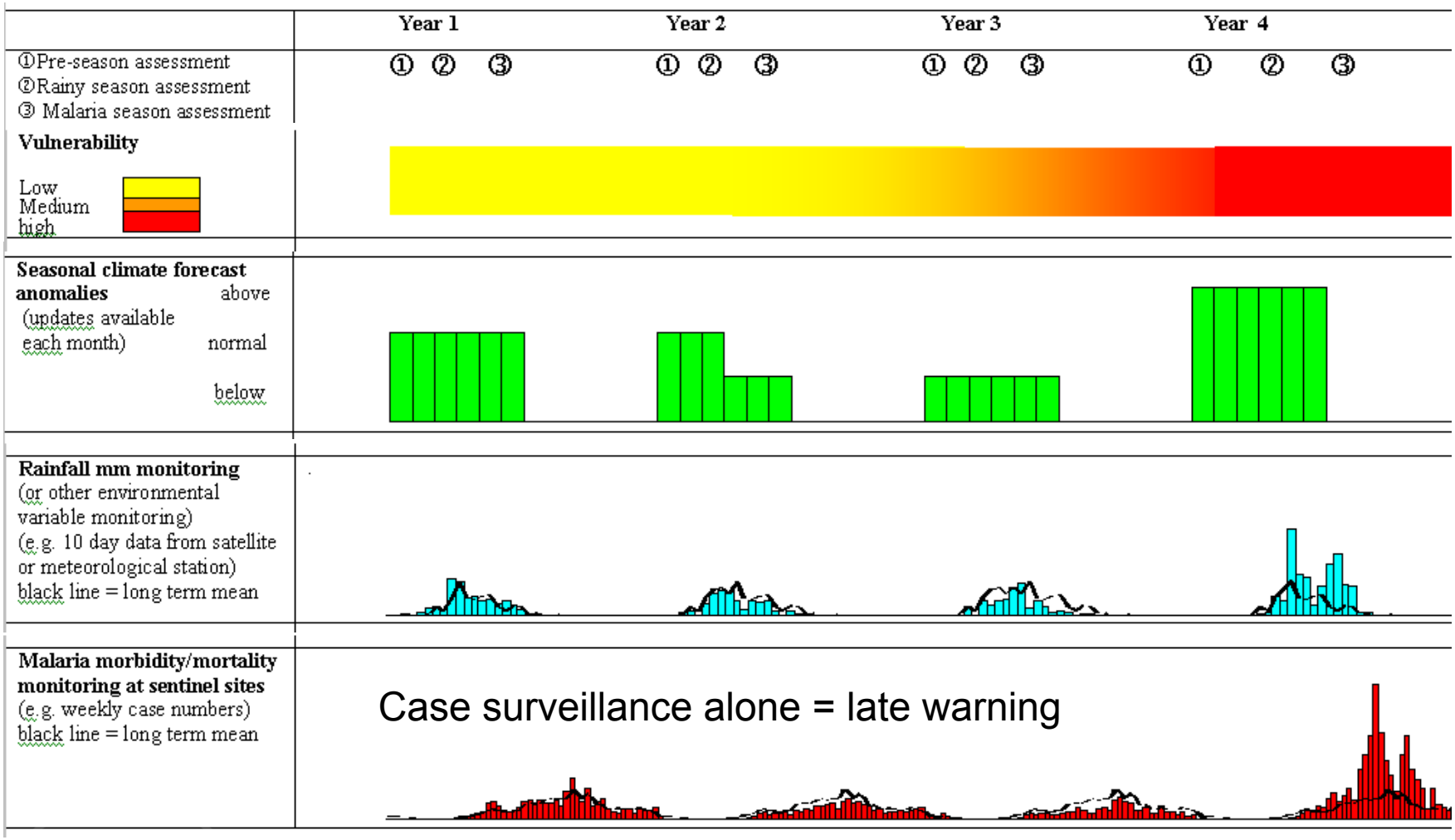
Humidity ?

Malaria

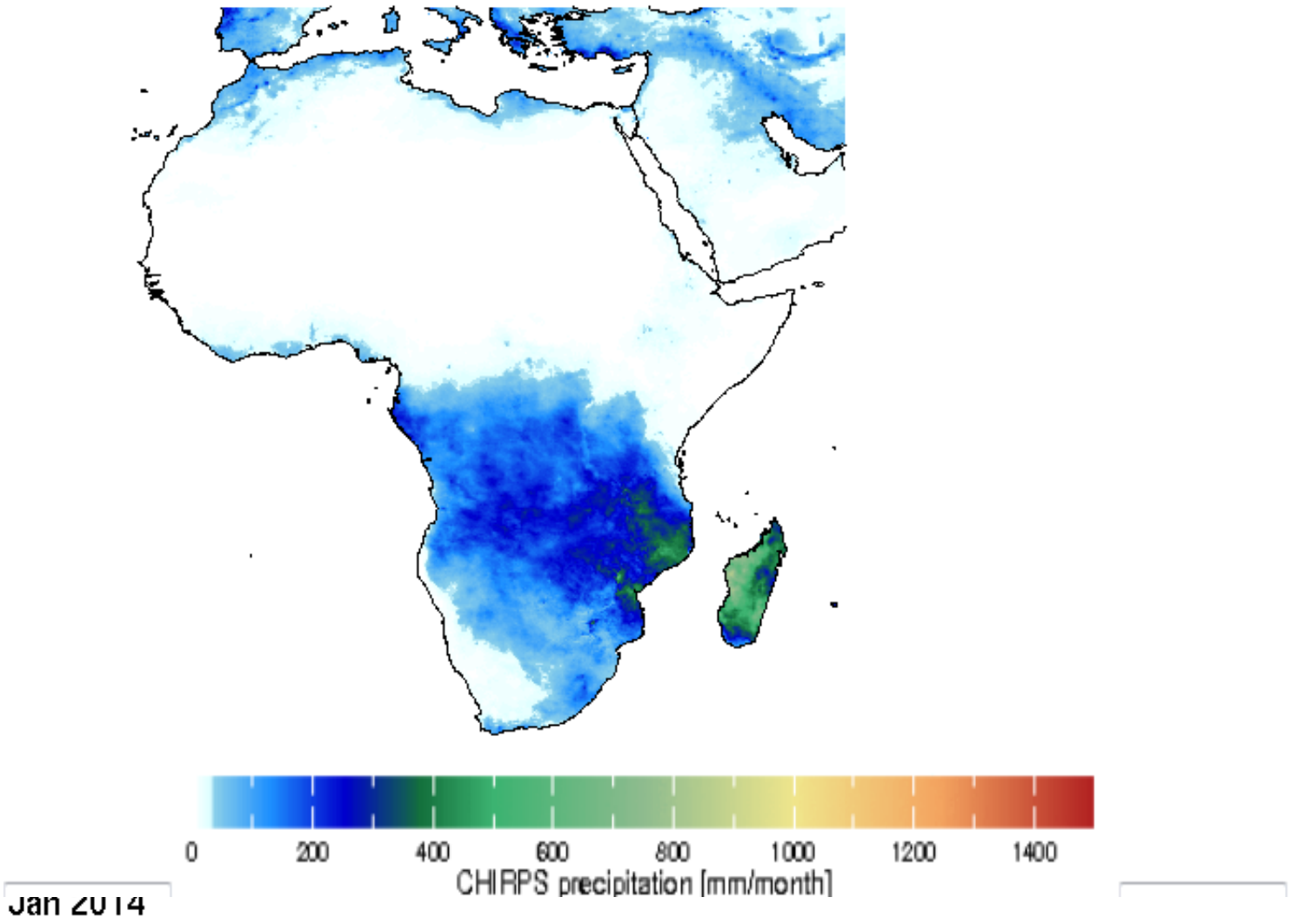
Collaborations with:
World Health Organization,
Ministries of Health in Africa,
PMI USAID



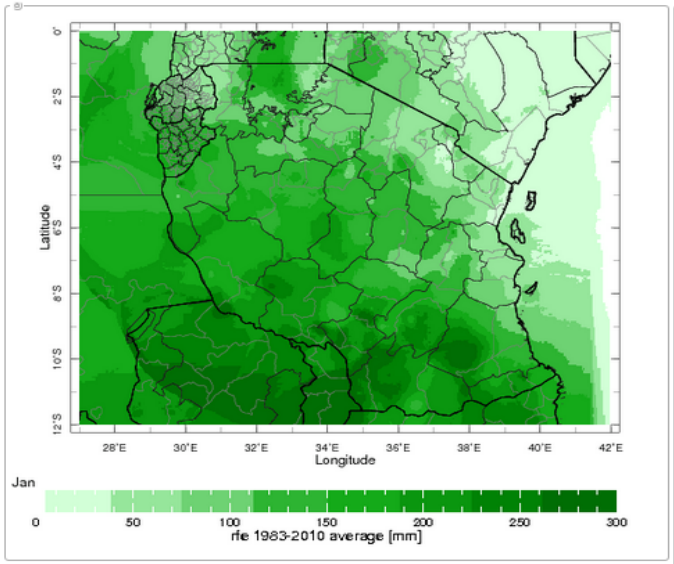
Monitor and predict year-to-year variations in incidence to create Early Warning Systems

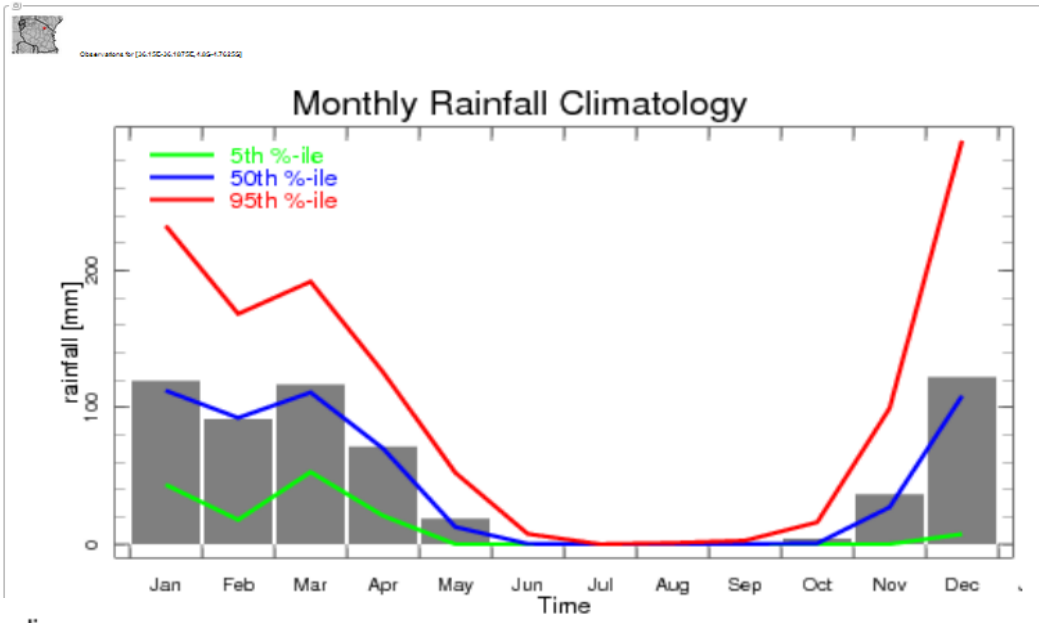


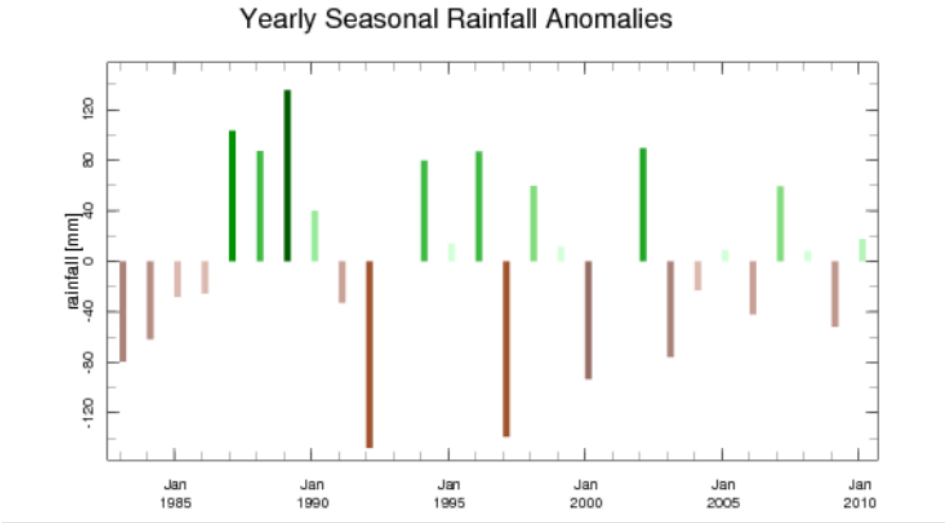
Precipitation for Africa CHIRPS (FEWS Net) daily data set from 1981 to present at 5km spatial resolution



Enhancing National Climate Services

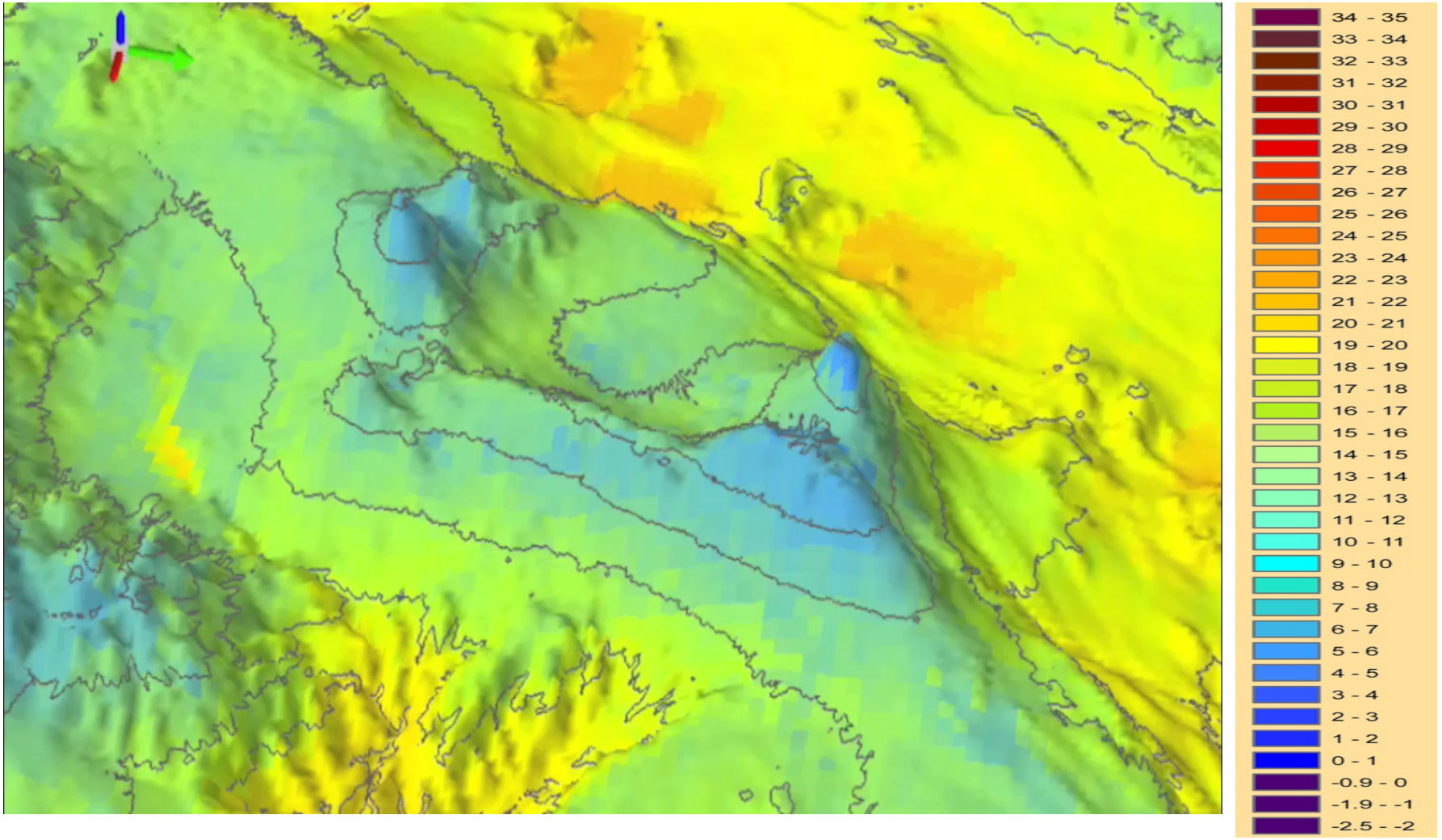




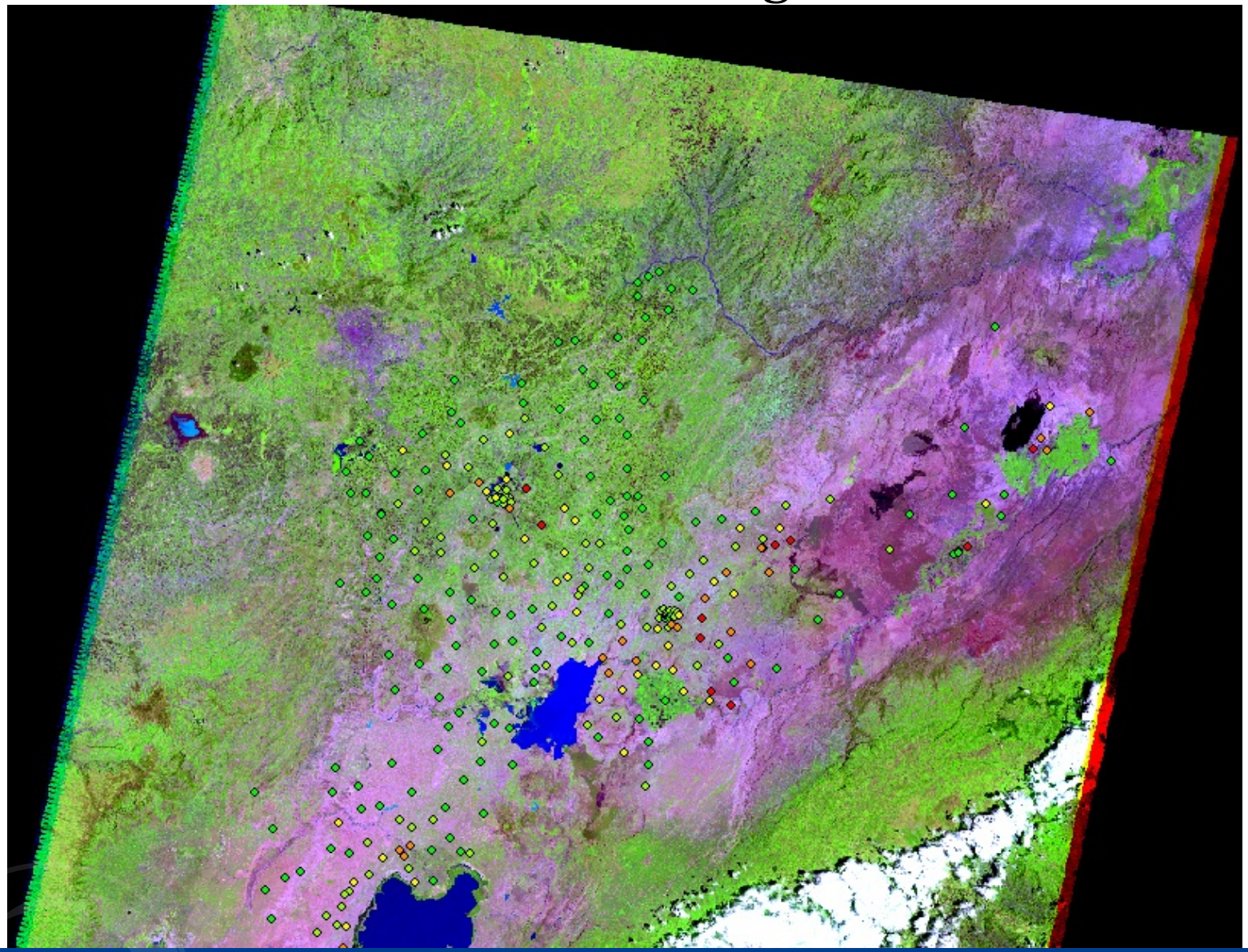


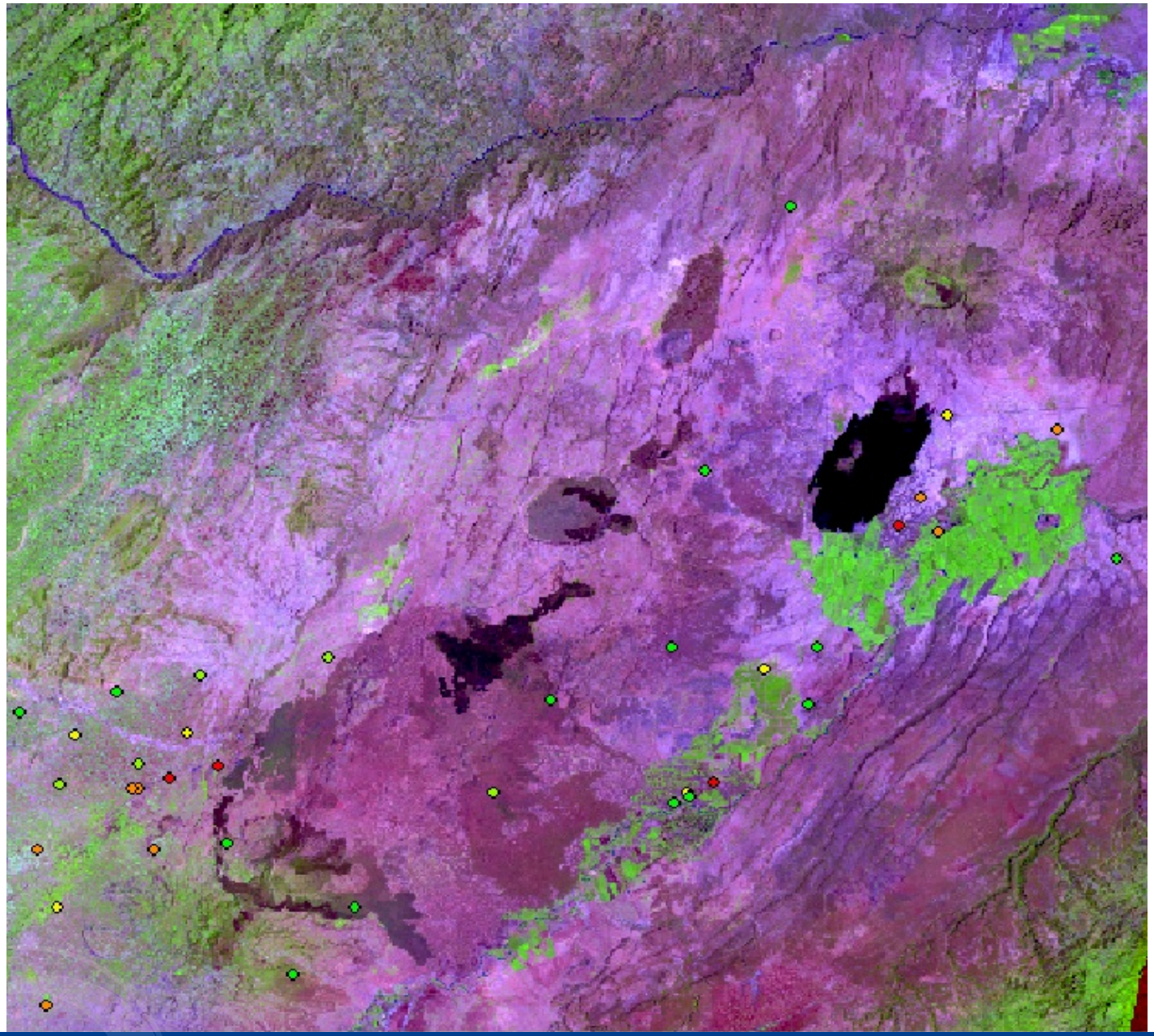
Operational in Ethiopia, Tanzania, Rwanda, Ghana, West Africa, Zambia, Madagascar, Kenya, soon in Malawi

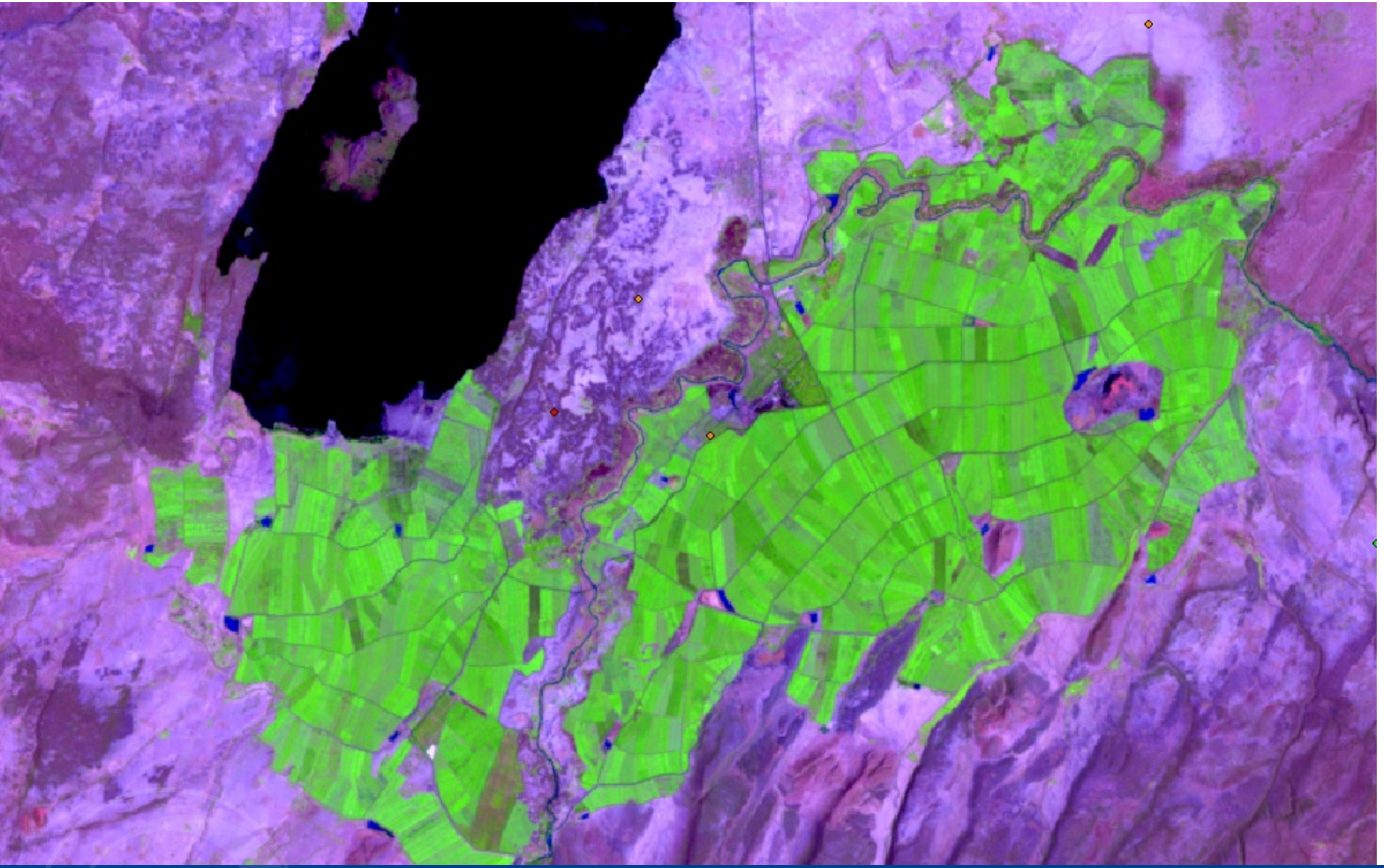
Land Surface Temperature from MODIS night and day



Water Bodies from LANDSAT image and Malaria



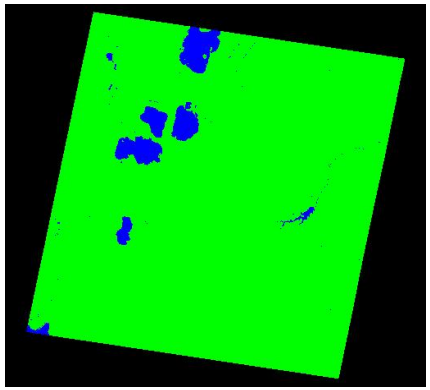




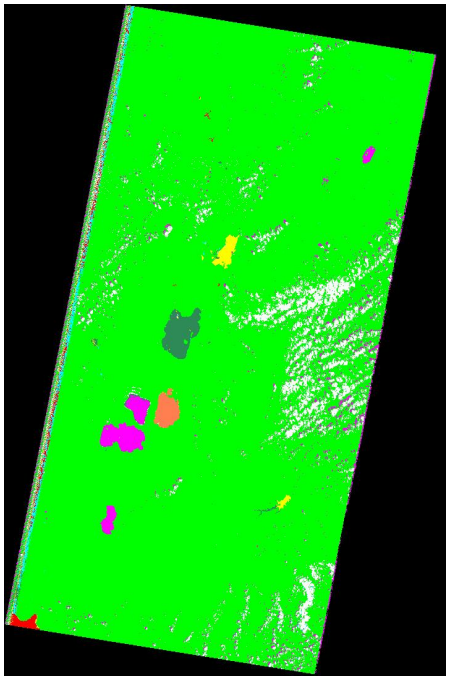
Developed new algorithms to automatically map open water and color properties using Landsat 7 and 8

Collaboration with NASA JPL

30-meter LANDSAT scene over East Shewa, Ethiopia

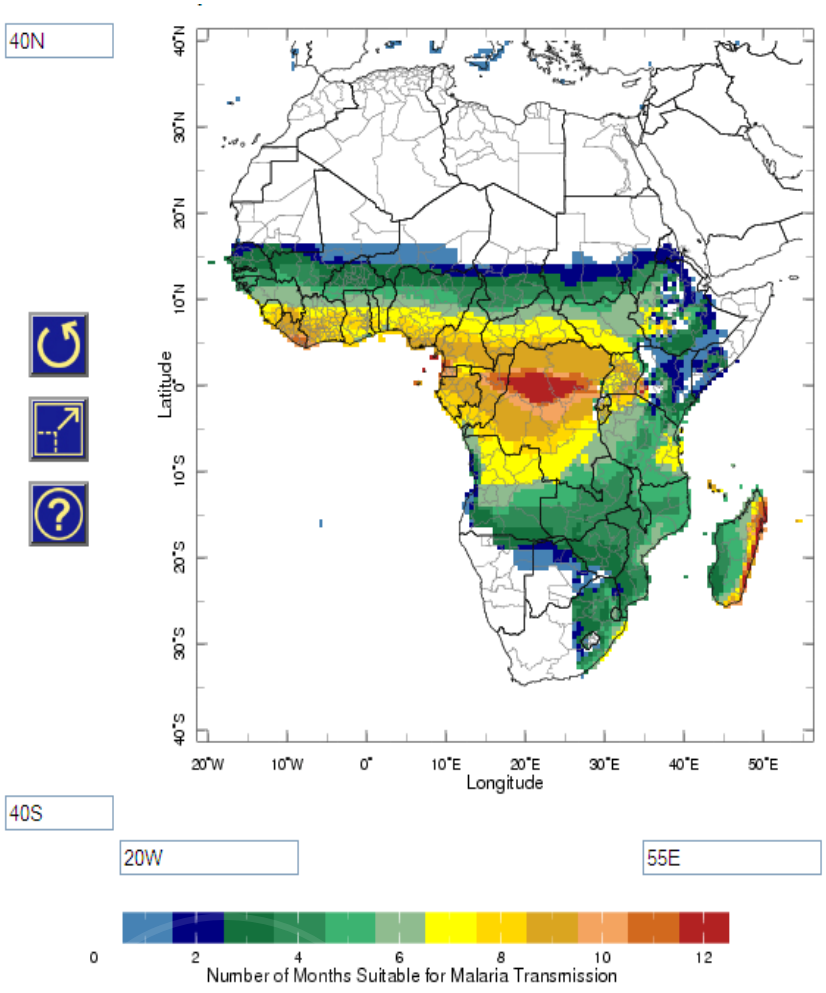


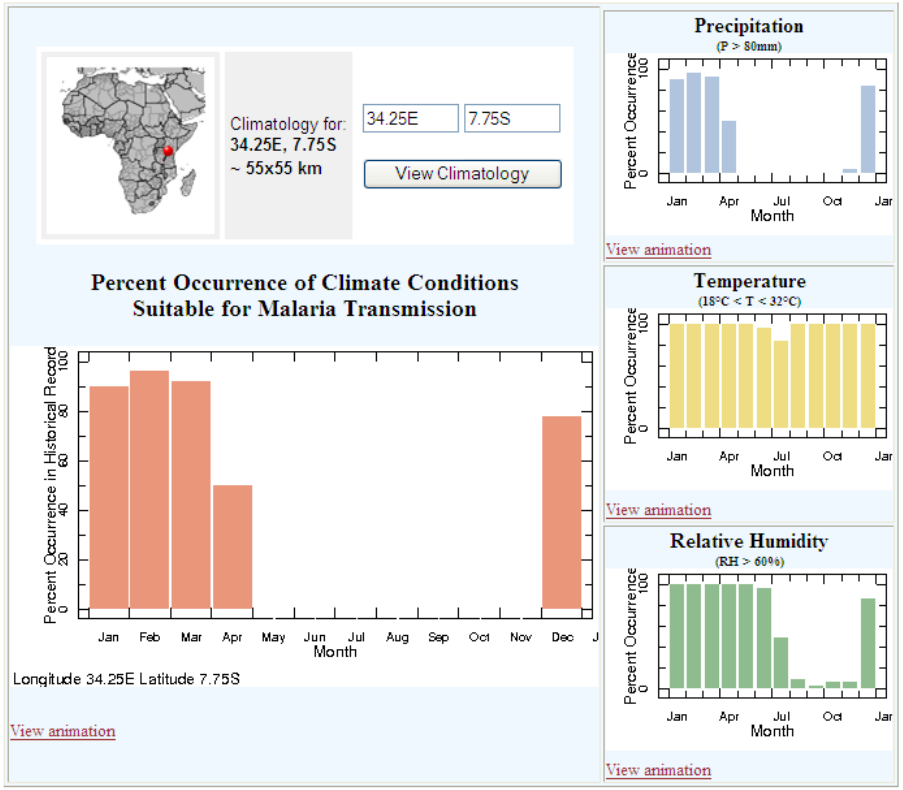
Open Water



Water Classes

Estimate seasonality of disease and timing of interventions





http://iridl.ldeo.columbia.edu/maproom/Health/Regional/Africa/Malaria/CSMT/index.html

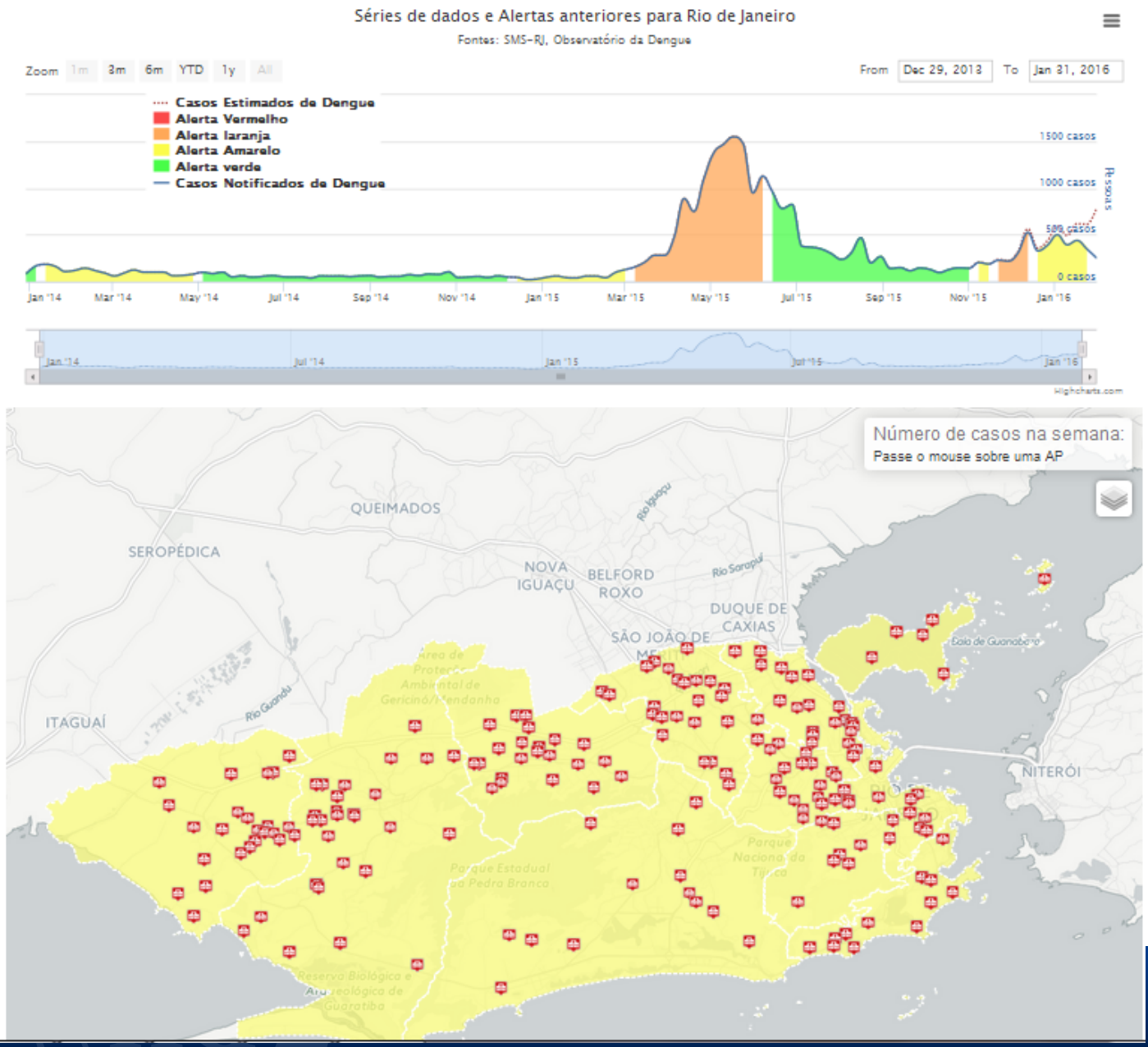
Missing the possibility to measure with remote sensing:

- Air temperature (inferred for the moment with Lands Surface Temperature)
- Humidity (estimated with vegetation moisture content as surrogate)

Dengue & Zika

Collaborations IRI - FIOCRUZ Rio de Janeiro, Brazil

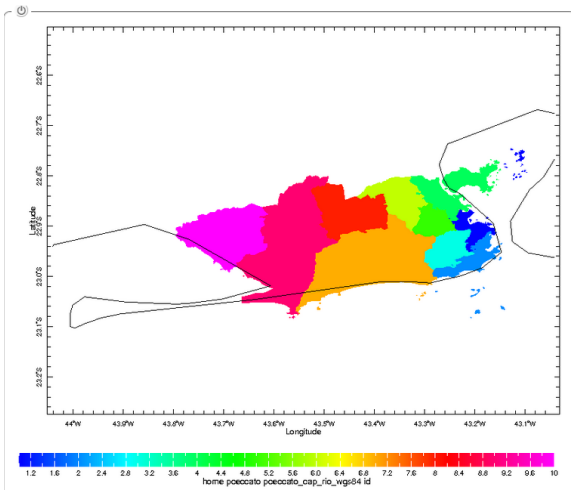
Situação da Dengue no Rio de Janeiro em 14 de fevereiro de 2016



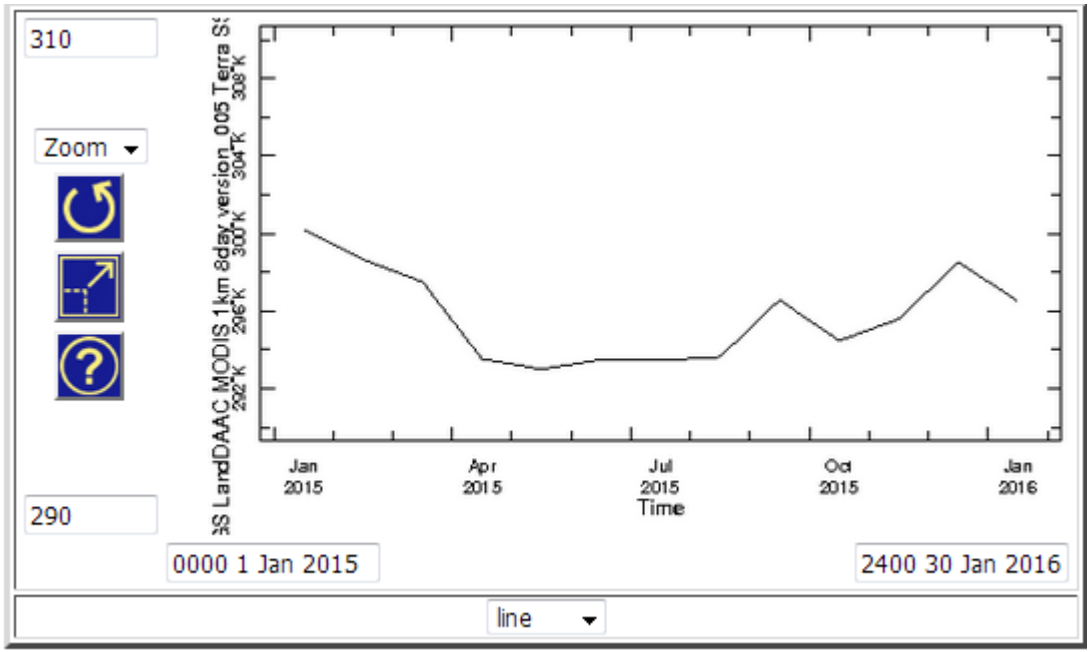
FIOCRUZ maps in almost real-time the dengue temporal and spatial trends in Rio de Janeiro

http://alerta.dengue.mat.br/alerta/rio/

IRI helps FIOCRUZ in extracting and analyzing climate data from IRI Data Library (precipitation, temperature, vegetation indices, water bodies)



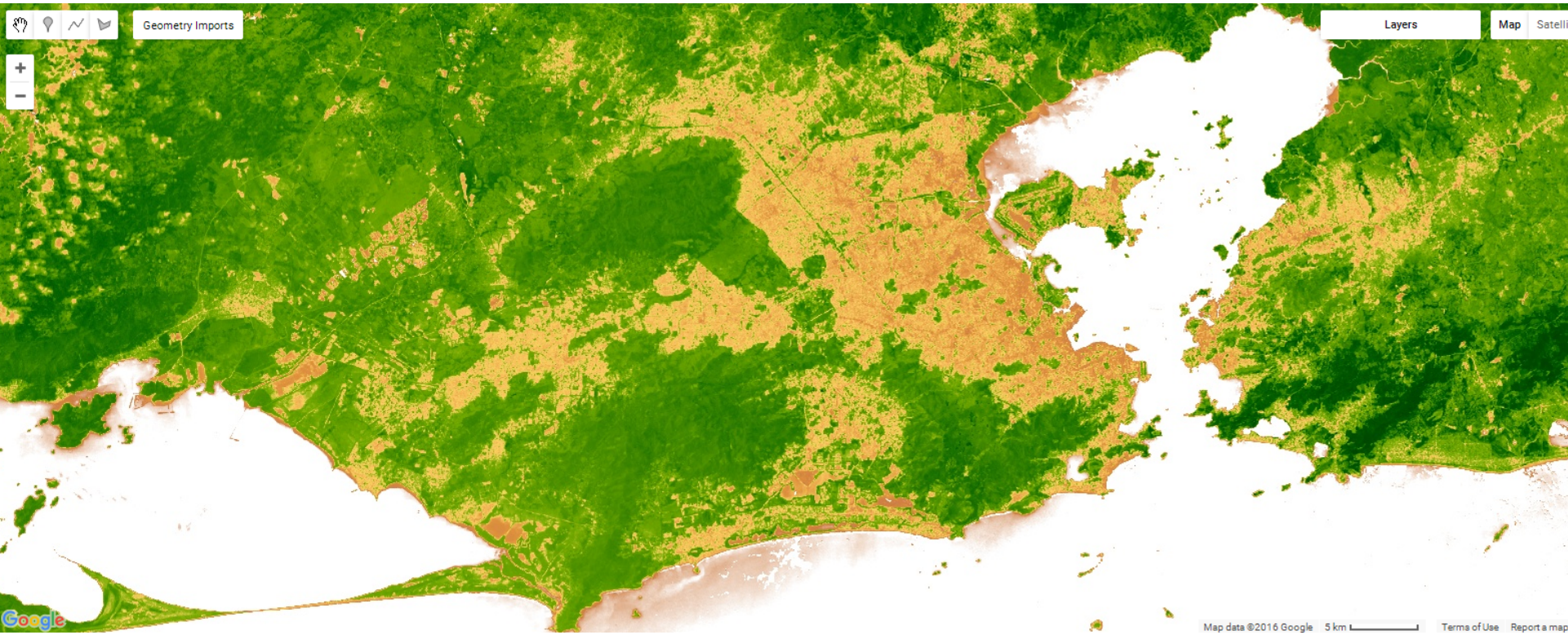
IRI Data Library interface



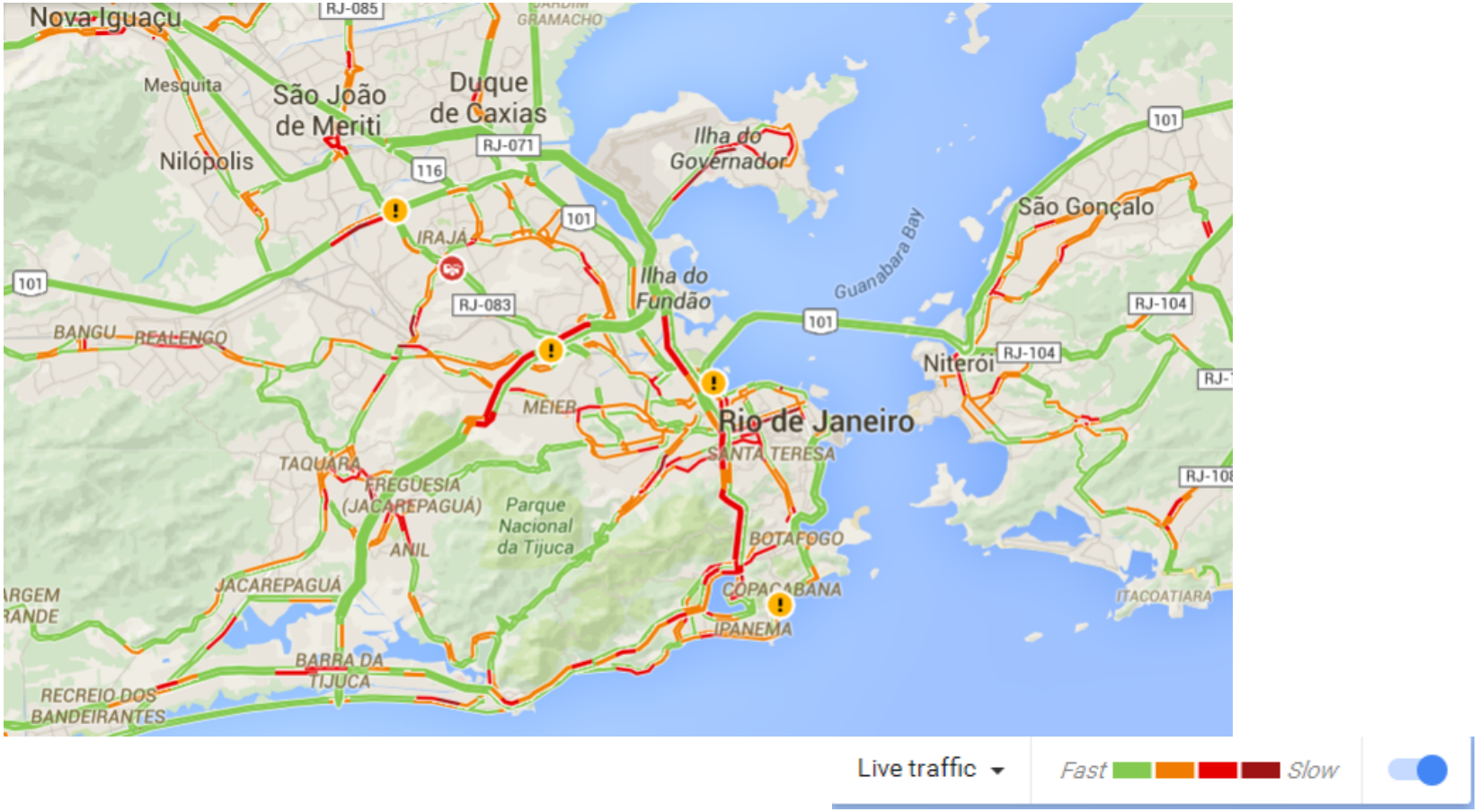
Temperature time series for one location

IRI works with Goggle Earth Engine to understand vulnerability and exposure using remotely-sensed images at high spatial resolution

IRI works with Goggle Earth Engine to understand vulnerability and exposure using remotely-sensed images at high spatial resolution

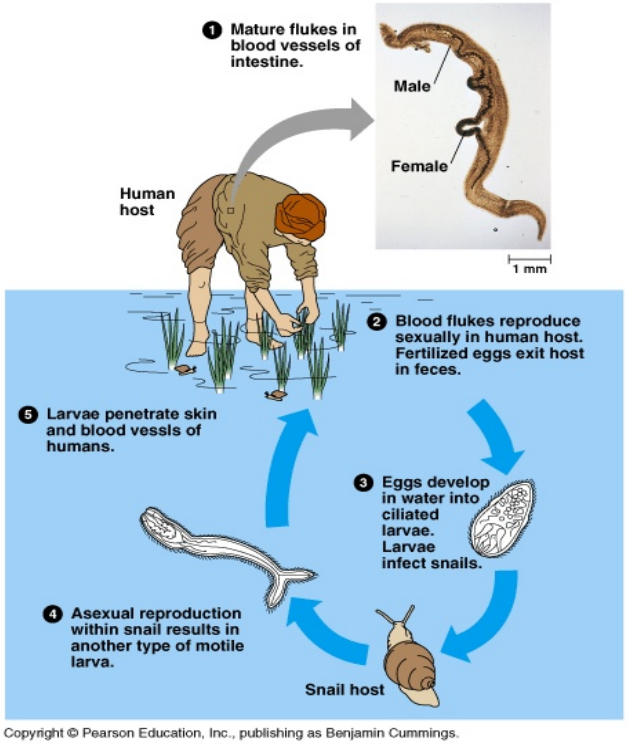


IRI works with Goggle Map to understand population movement and network impacts on disease distribution



Schistosomiasis

Collaboration with Kwazulu Natal University and WHO TDR



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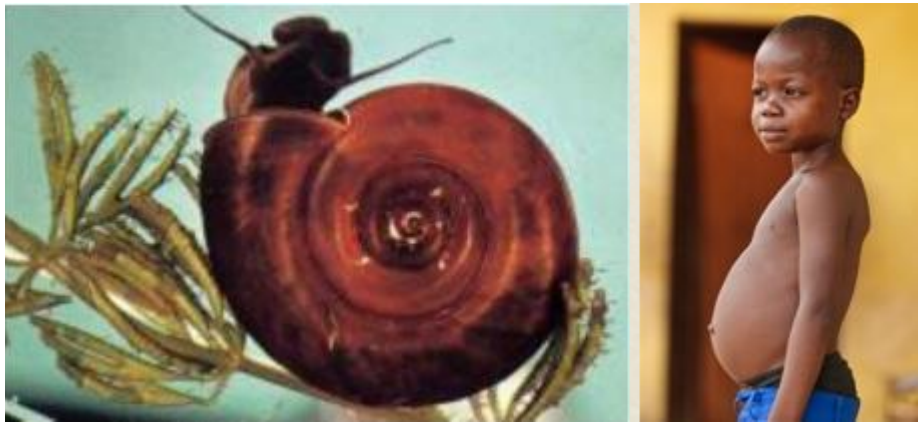
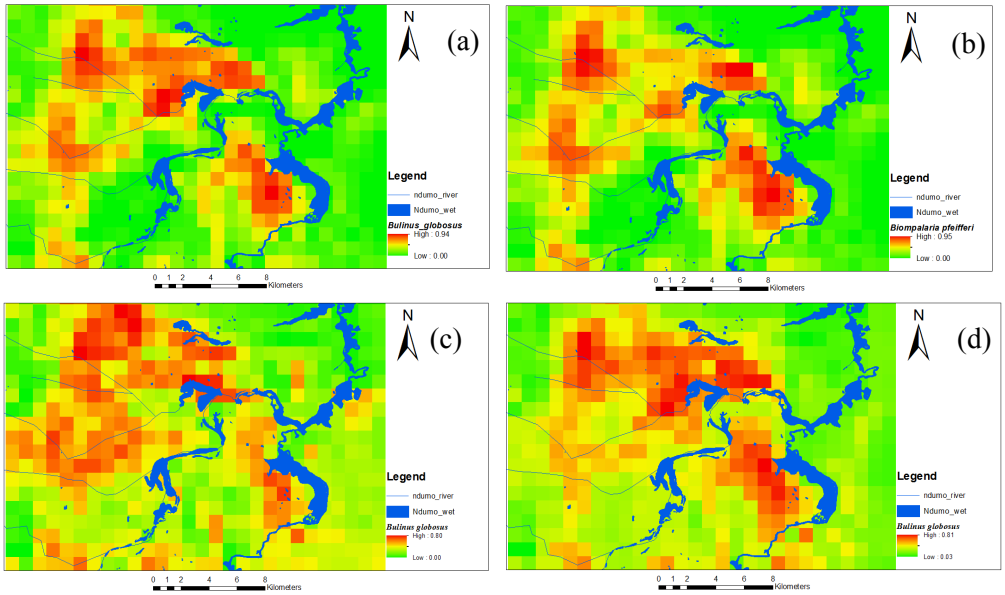




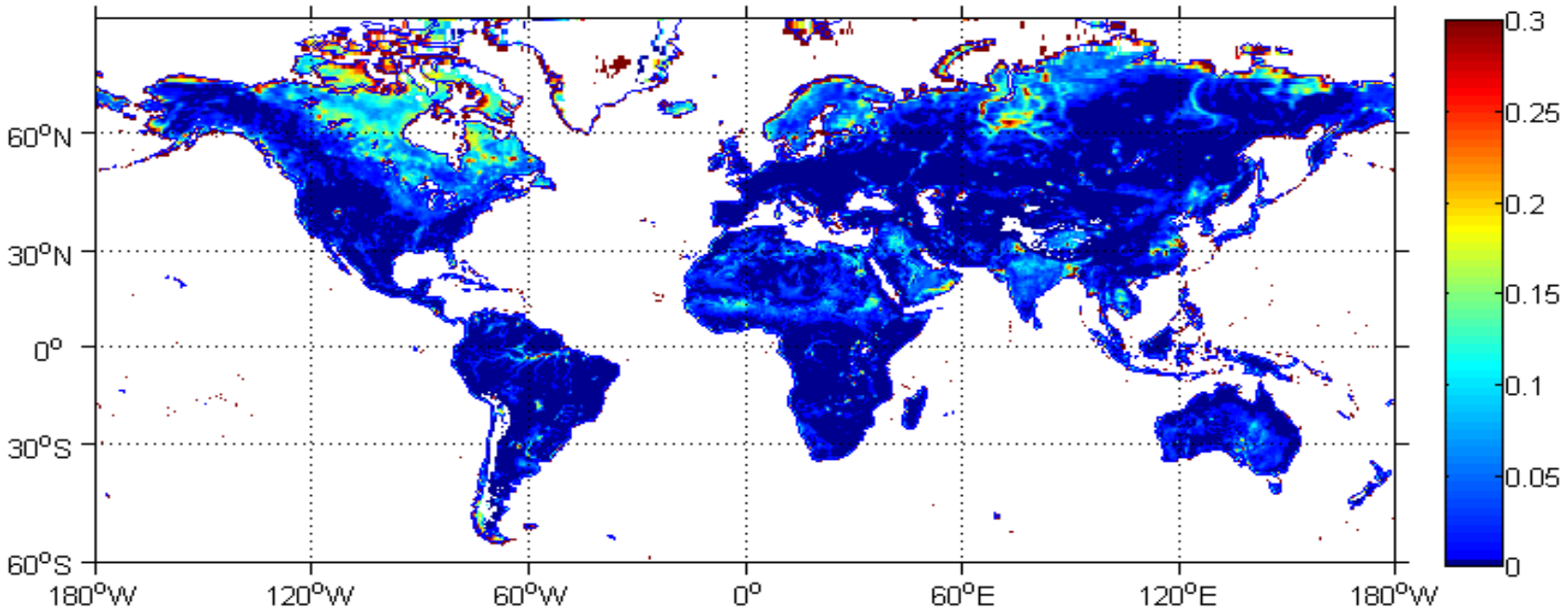
Leishmaniasis

Collaborations with:
Médecins Sans Frontières,
South Sudan

Products accessible via the IRI Data Library

Collaboration with CUNY

Daily, 6-Day, 10-Day
from 1999 to 2015

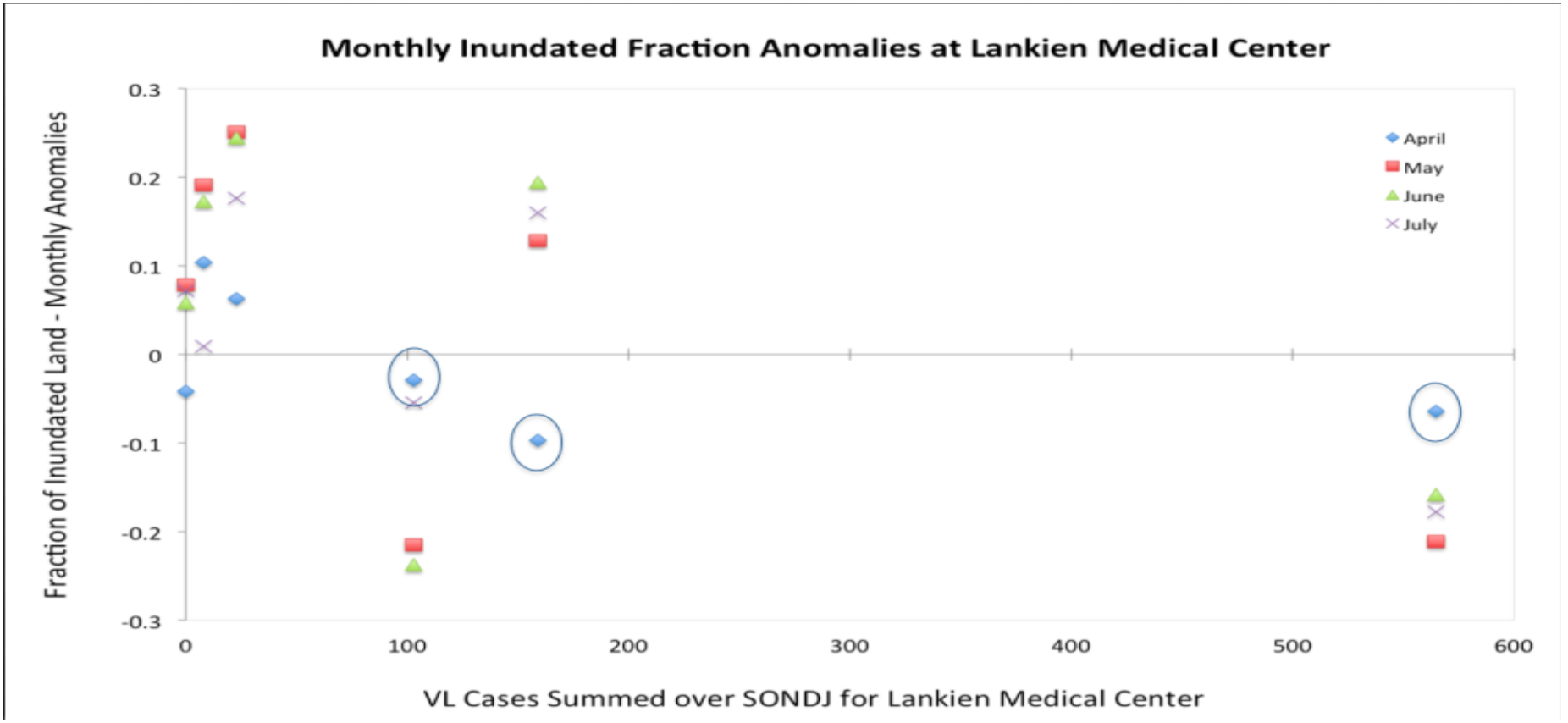


http://iridl.ldeo.columbia.edu/SOURCES/.NASA/.JPL/.wetlands/

SERVIR GLOBAL

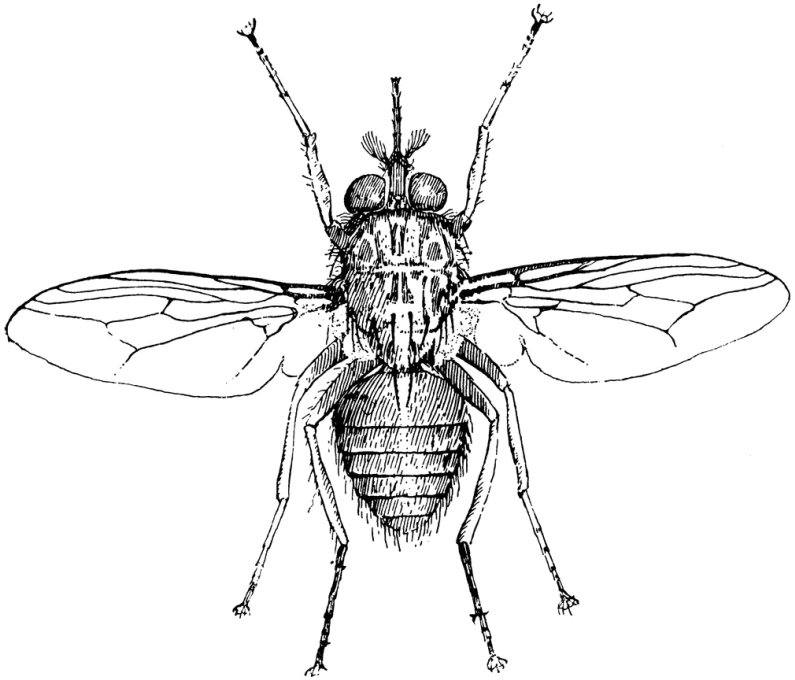
Leishmaniasis

Collaborations with Médecins Sans Frontières, South Sudan



Trypanosomiasis

Collaborations with:
World Health Organization,
Nelson Mandela University



Masai village in Tanzania affected by trypanosomiasis

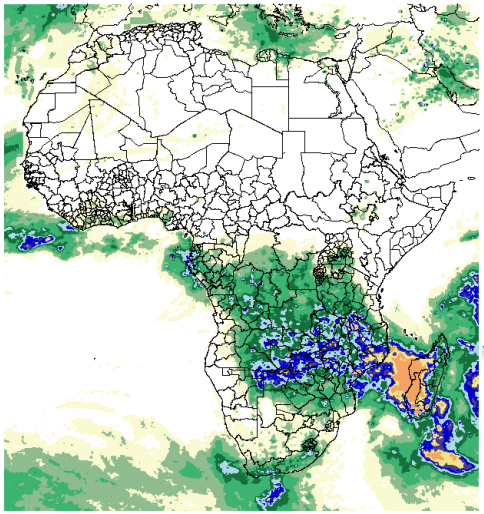
John Hargrove providing expertise on tsetse fly

Monitoring Tsetse Habitats for Targeting Controls

Connecting Space

To Village

Dissemination of Information to Local Communities



1–10 Jan 2014

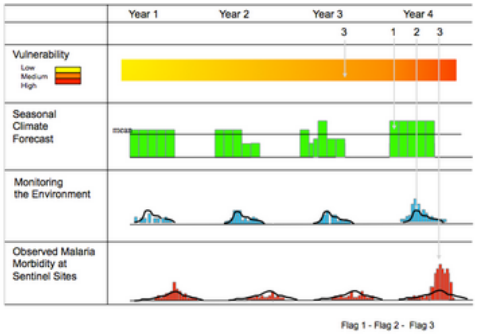
IRI Data Library:
http://iridl.ldeo.columbia.edu/maproom/

IRI Data Library http://iridl.ldeo.columbia.edu/

Malaria Early Warning System

The Malaria Early Warning System (MEWS) aids in the prediction of malaria outbreaks. The system consists of four elements; Vulnerability, Seasonal Climate Forecasts, Monitoring the Environment and Observed Malaria Morbidity. In certain regions, these products may be used to determine the timing and severity of an outbreak.

This maproom outlines each element of the MEWS. Each element contains products, some of which may be used to help determine the risk of a malaria outbreak in a specific region.



Using all of the elements as a system may be useful in understanding the socioeconomic and climatic drivers of malaria in particular regions. The diagram above depicts how the four elements can be employed on different time scales using flags to raise concern of a potential outbreak.

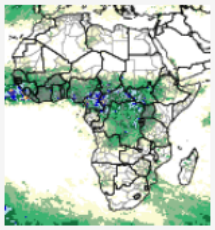
Climatic and environmental variables can

Vulnerability | Seasonal Climate Forecast | Monitoring The Environment | Observed Malaria Morbidity

Monitoring The Environment

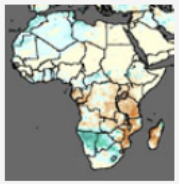
Dekadal (10-day) Precipitation

This map shows dekadal (10-day) precipitation estimates from the Climate Prediction Center.



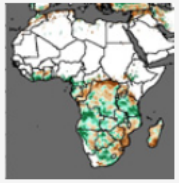
Precipitation Estimate Differences

This map shows dekadal (10-day) precipitation estimates as the difference from the short term average (from 2000 to last recent complete year).



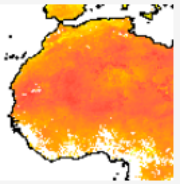
Precipitation Estimate Percentages

This map shows dekadal (10-day) precipitation estimates as a percentage of the short term average (from 2000 to last complete year).



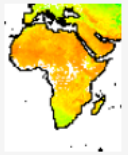
Inferred Maximum Air Temperature

This map shows approximated maximum air temperatures at 2 meters above the ground.



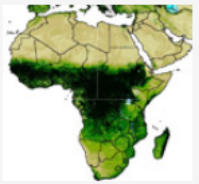
Minimum Land Surface Temperature (LST)

This map shows minimum land surface temperature (LST) used as a proxy for monitoring minimum air temperature.



Measures of Vegetation

This tool produces maps of estimated vegetation using data from NASA's MODIS sensor.

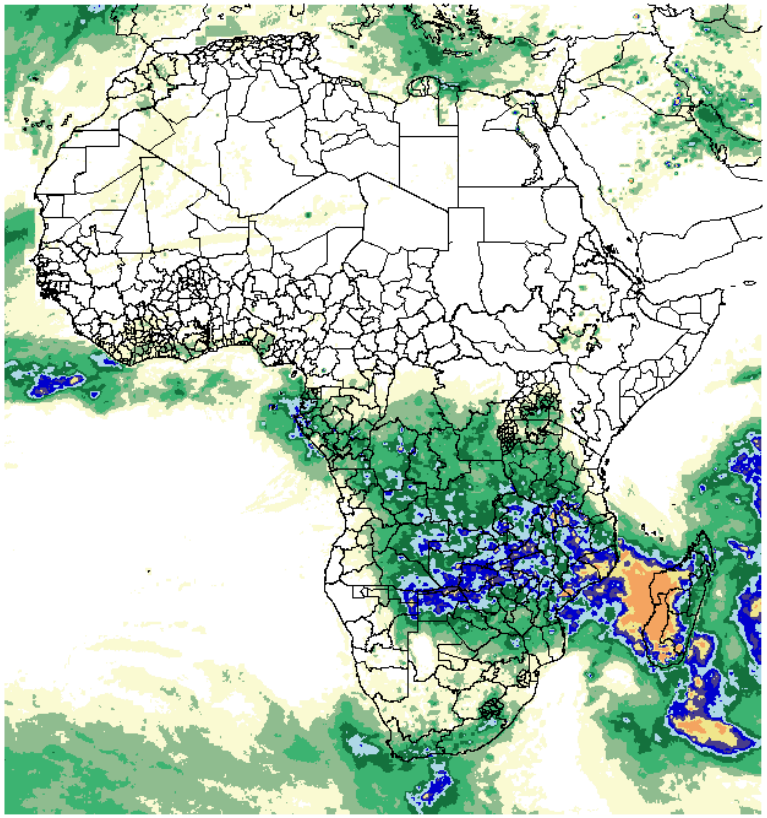


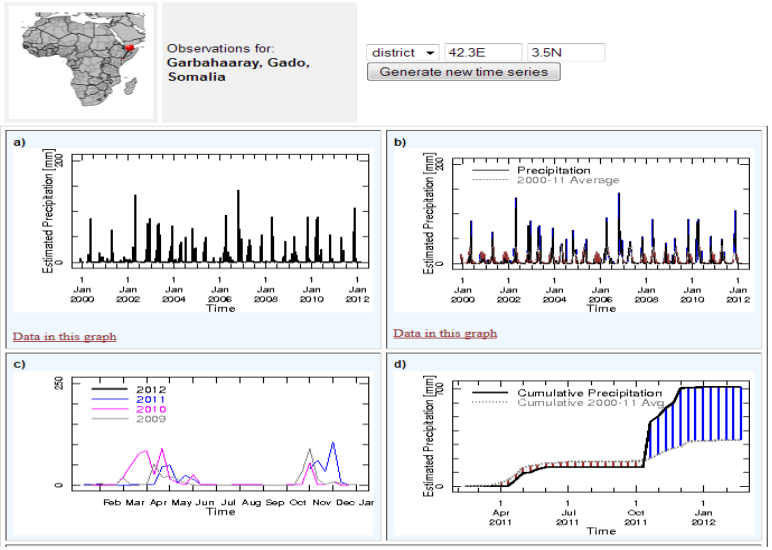
Vectorial Capacity

This map shows a Vectorial Capacity (VCAP) model that defines precipitation and temperature as the limiting factors of malaria incidence. VCAP is the daily rate at which future malaria inoculations could arise from a

Provide Easy:

Access, Visualization, Analysis and Download





IRI Data Library:
http://iridl.ldeo.columbia.edu/maproom/

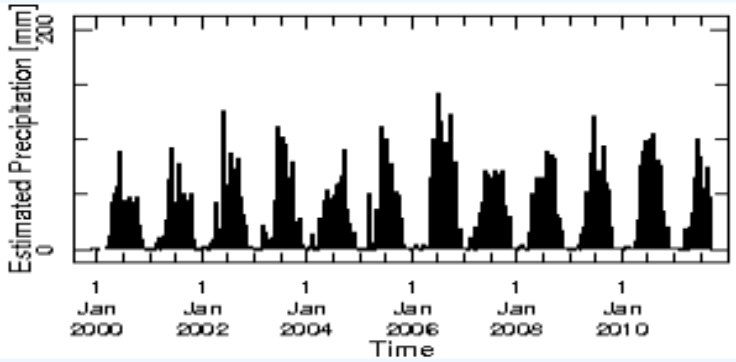
1-10 Jan 2014

Observations for:
Kemashi, Benshangul, Ethiopia

district | 36.1E | 9.3N

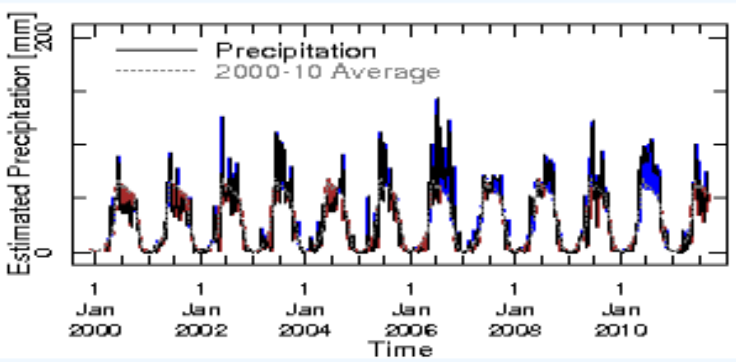
Generate new time series

a)



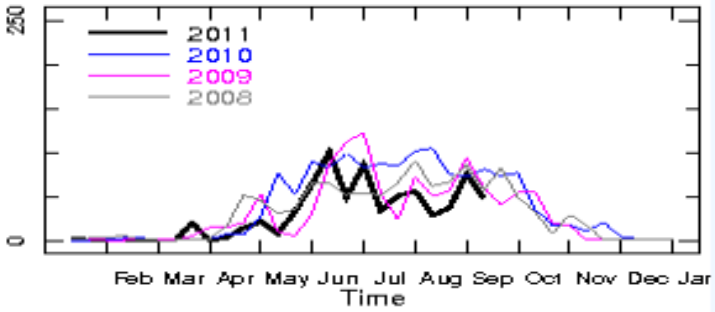
Data in this graph

b)

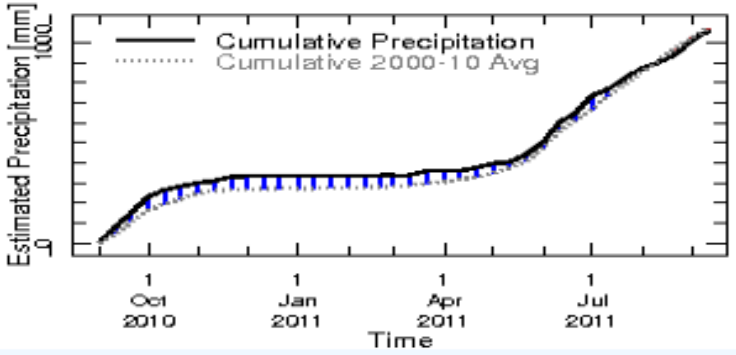


Data in this graph

c)



d)



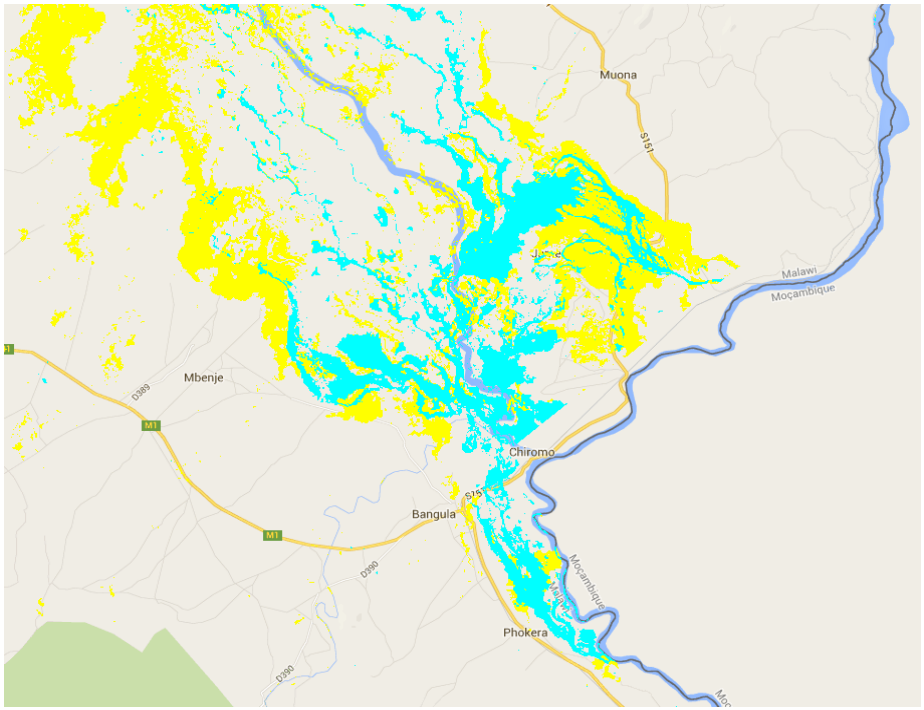
International Federation of Red Cross and Red Crescent Societies

- **Engagement with International Federation for Red Cross and Red Crescent (IFRC) on Floods**

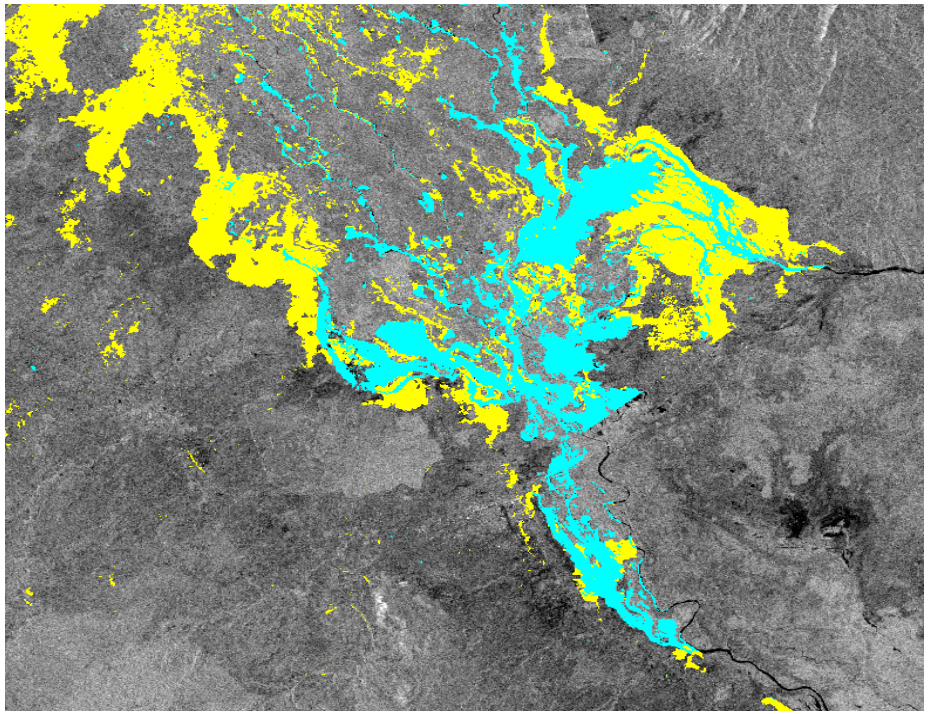
- Test the 6-day forecast provided through the IRI Data Library and the mapping of flood events on global scale.
- Using the case study of January 2015 floods in Malawi
- We have analyzed several flood maps derived from Sentinel 1 SAR, LANDSAT 8 with different flood products produced by Dartmouth Flood Obs, NASA, JRC.

- Comparison of Flood Detection Products
- Revealed large discrepancies in the accuracy of detecting different flood types

LANDSAT flood mapping in GEE



Sentinel 1 SAR flood mapping in GEE



January Flood
February Flood

Desert Locust

Solitary

Gregarious

Desert Locust Swarms

Swarm Invasions

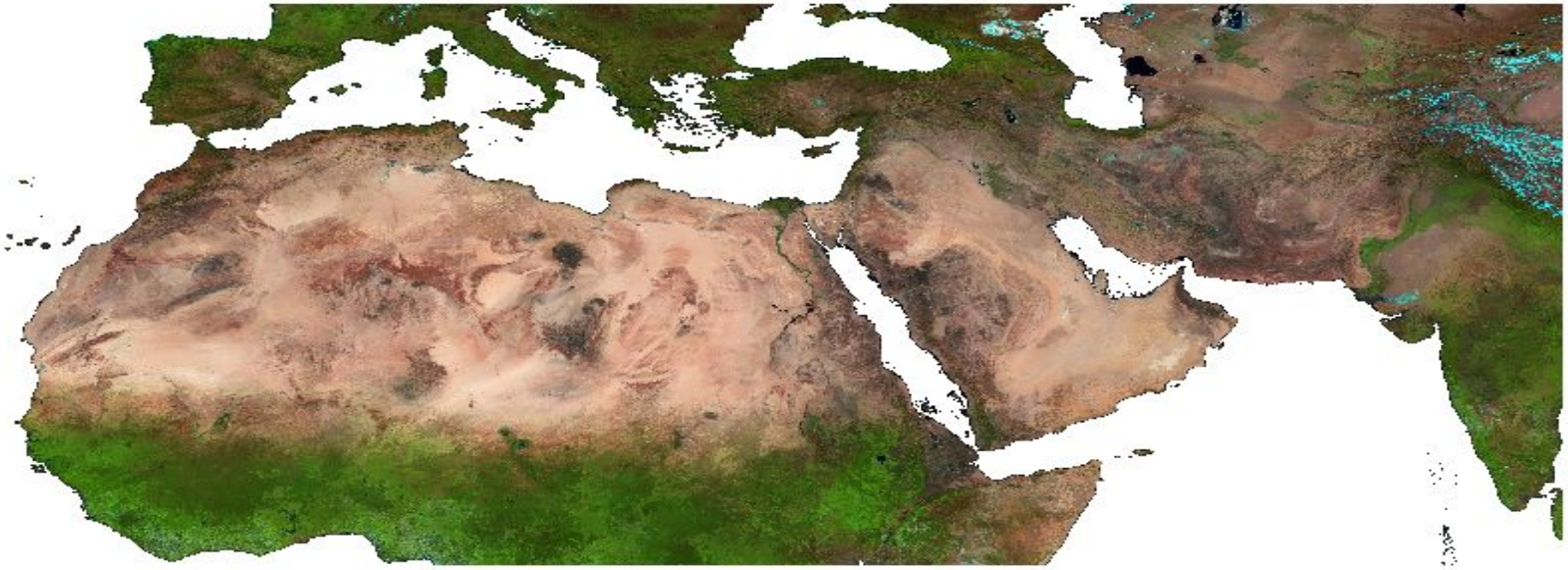
Cairo, Egypt

Nouakchott, Mauritania

Monitoring Desert Areas: *e.g.* in Niger, Africa

Areas equivalent to Texas

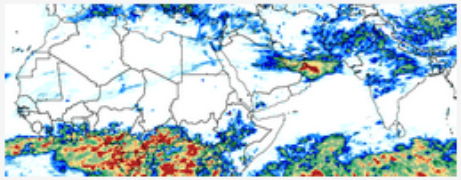
Area to be covered



Products Provided

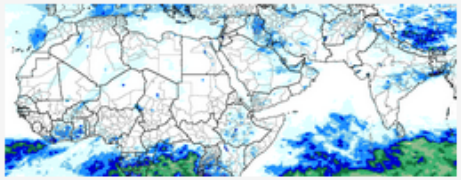
Dekadal Rainfall Estimates

Accumulated rainfall during the most recent dekad based on estimates from the Climate Prediction Center Morphing technique.



Monthly Rainfall Estimates

Accumulated rainfall during the most recent month based on estimates from the Climate Prediction Center Morphing technique.

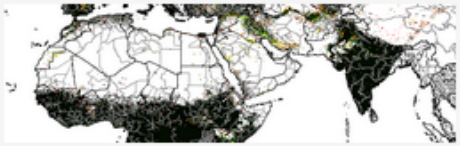


Rainfall Analysis Tool

A rainfall monitoring product based on daily rainfall estimates from the Climate Prediction Center.

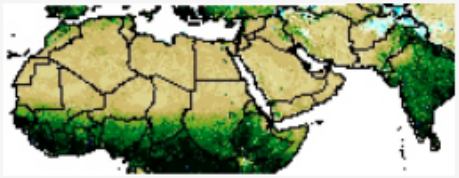
Greenness Estimates

A critical factor in Locust control is areas which have recently transitioned from desert to vegetation. Greenness is the number of dekads (approximately ten days) passed since vegetation onset. Thus greenness is a measure which highlights this critical transition.



MODIS Analysis Tool

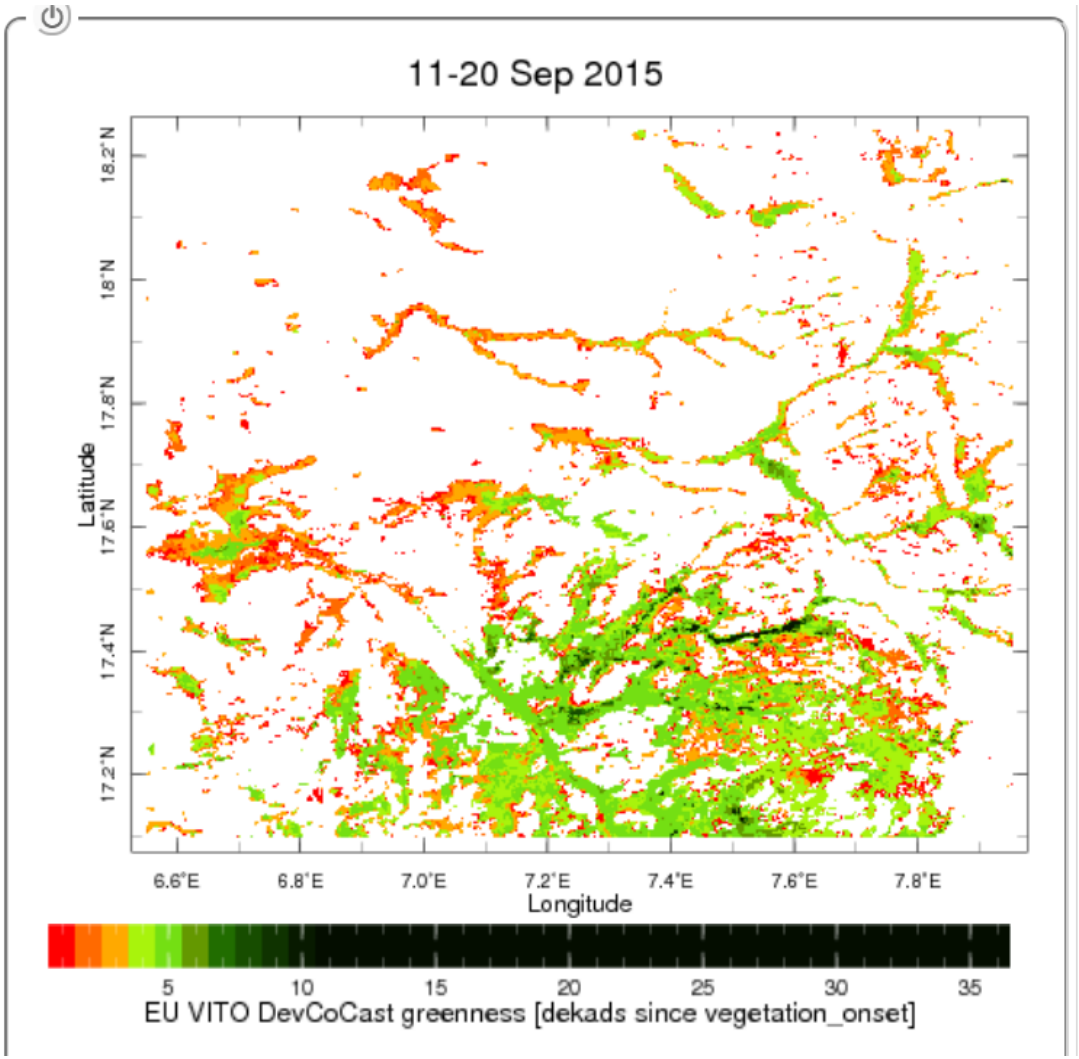
The images on this page are derived from The Moderate Resolution Imaging Spectroradiometer (MODIS) sensor at 250m spatial resolution provided every 16 days. This interface facilitates access to estimates of vegetation from MODIS images provided by the United States Geological Survey. Images are available for West Africa, East Africa, and Southwest Asia.



NASA Worldview

Satellite Imagery for Vegetation, Dust Storms, Fires, Drought, Smoke Plumes, Ash Plumes, Air Quality, Severe Storms, and Floods.

Products Provided



Evolution of Greenness every 10 days

Data Library Used by DL Officers in 23 Countries

Information Provided to Control Teams

Control Measures

Training Activities

Training for Ministries of Health, U.N. WHO, USAID PMI/RTI, Nairobi, June 2013

Training for WHO TDR: 5 research communities (West Africa, Kenya, Tanzania, South Africa, Bostwana) at Nelson Mandela University, Arusha Tanzania 21st-25th July 2014

Training Workshop for TMA, WMO, Ministry of Health, USAID PMI/RTI, Dar es Salaam, Tanzania June 2014

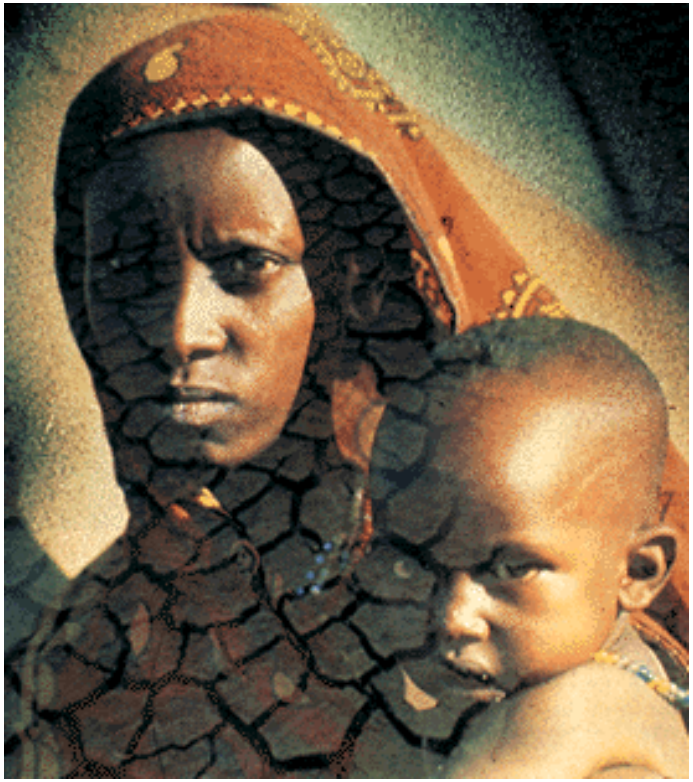
Denis Macharia, RCMRD at IRI
August 1-15, 2014

Workshop and Training for WMO Global Framework for Climate Services GFCS, Ministries of Health, Malawi, Tanzania, 15th-24th June 2015

Training for WHO TDR: 5 research communities (West Africa, Kenya, Tanzania, South Africa, Botswana) at World Health Organization, Geneva, Switzerland 14th-17th July 2015

Climate and Health ICTP, FIOCRUZ, Rio de Janeiro, Brazil 20th-30th July 2015

RCMRD Feb 2016



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